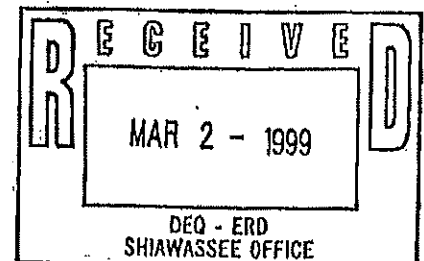


# Exhibit E

**CRA**

## GROUNDWATER QUALITY ASSESSMENT REPORT

**GENERAL MOTORS CORPORATION  
PROVING GROUNDS  
MILFORD, MICHIGAN**



**FEBRUARY 1999**

**REF. NO. 10617 (4)**

This report is printed on recycled paper.

**Prepared By:**

**Conestoga-Rovers & Associates**  
11100 Metro Airport Center Drive, Suite #160  
Romulus, Michigan 48174  
(734) 942-0909 Office (734) 942-1858 Fax

## TABLE OF CONTENTS

|   | <u>Page</u> |
|---|-------------|
| 1.0 INTRODUCTION.....   | 1           |
| 2.0 SITE BACKGROUND .....                                       | 2           |
| 3.0 GROUNDWATER MONITORING FIELD ACTIVITIES.....                | 3           |
| 3.1 SCOPE OF WORK.....  | 3           |
| 3.2 VERTICAL AQUIFER SAMPLING.....                              | 3           |
| 3.2.1 LABORATORY ANALYTICAL RESULTS.....                        | 4           |
| 3.3 MONITORING WELL INSTALLATION .....                          | 4           |
| 3.3.1 INSTALLATION PROCEDURES .....                             | 4           |
| 3.3.2 WELL DEVELOPMENT .....                                    | 5           |
| 3.4 FIELD MONITORING.....                                       | 5           |
| 3.5 MONITORING WELL PURGING AND SAMPLING .....                  | 6           |
| 3.6 DECONTAMINATION PROCEDURES.....                             | 6           |
| 3.7 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)<br>SAMPLING ..... | 7           |
| 4.0 GROUNDWATER MONITORING RESULTS .....                        | 8           |
| 4.1 GROUNDWATER ELEVATIONS.....                                 | 8           |
| 4.2 FIELD MONITORING.....                                       | 8           |
| 4.3 LABORATORY ANALYTICAL RESULTS.....                          | 8           |
| 5.0 SURFACE WATER EVALUATION MAPPING .....                      | 9           |
| 5.1 INSTALLATION OF STAFF GAUGES.....                           | 9           |
| 5.2 SURVEYING OF MONITORING WELLS AND STAFF GAUGES .....        | 9           |
| 5.3 STATIC WATER LEVEL MEASUREMENTS .....                       | 9           |
| 6.0 SUMMARY .....   | 10          |

LIST OF FIGURES  
(following text)

|            |  |
|------------|--|
| FIGURE 1.1 | SITE PLAN                                    |
| FIGURE 3.1 | MONITORING WELL AND STAFF GAUGE LOCATION     |
| FIGURE 4.1 | GROUNDWATER AND SURFACE WATER FLOW DIRECTION |

LIST OF TABLES

|           |  |
|-----------|--|
| TABLE 3.1 | SAMPLE KEY - VERTICAL AQUIFER SAMPLING                             |
| TABLE 3.2 | GROUNDWATER QUALITY FIELD MEASUREMENTS - VERTICAL AQUIFER SAMPLING |
| TABLE 3.3 | LABORATORY ANALYTICAL RESULTS - VERTICAL AQUIFER SAMPLING          |
| TABLE 3.4 | SURFACE WATER AND GROUNDWATER ELEVATIONS                           |
| TABLE 3.5 | GROUNDWATER QUALITY FIELD MEASUREMENTS - MONITORING WELLS          |
| TABLE 3.6 | SAMPLE KEY - GROUNDWATER SAMPLING                                  |
| TABLE 4.1 | LABORATORY ANALYTICAL RESULTS - GROUNDWATER SAMPLING               |

LIST OF APPENDICES

|            |                                    |
|------------|------------------------------------|
| APPENDIX A | CHAIN OF CUSTODY FORMS             |
| APPENDIX B | LABORATORY ANALYTICAL REPORTS      |
| APPENDIX C | STRATIGRAPHIC LOGS                 |
| APPENDIX D | DATA QUALITY ASSESSMENT MEMORANDUM |

## 1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) conducted a groundwater monitoring event at the southwest corner of the General Motors Corporation (GM) Proving Grounds in Milford, Michigan (Site). The Site location is presented on Figure 1.1. This work was implemented, as described in the Michigan Department of Environmental Quality (MDEQ) approved Work Plan for Assessment of Sodium and Chlorides in Groundwater (Work Plan) dated August 1998, during November and December 1998 and January 1999.

This groundwater monitoring activity included vertical aquifer sampling, installation of three (3) temporary groundwater monitoring wells, groundwater static water level measurements, and groundwater sampling. Groundwater samples were collected and analyzed for dissolved sodium and total chloride. In addition to the groundwater monitoring, six (6) surface water staff gauges were installed, surveyed and measured for surface water elevations to support the evaluation of groundwater flow directions.

The following Groundwater Quality Assessment Report (Report) presents the field activities conducted and results obtained during implementation of the Work Plan. This Report is organized into the following sections:

- 2.0 Site Background;
- 3.0 Groundwater Monitoring Field Activities;
- 4.0 Groundwater Monitoring Results;
- 5.0 Surface Water Elevation Mapping; and
- 6.0 Summary.

2.0 SITE BACKGROUND

The Site is located along the border of Livingston and Oakland Counties and occupies approximately 4,000 acres of land (see Figure 1.1). The Site is used as a vehicle testing and development facility. Sodium and chloride were reportedly detected in groundwater on the property southwest of the Site, as described in a report prepared for the property owner (Water Supply Evaluation, Insight Environmental Services, Inc. (Insight), July, 1997). The Insight Report assumed, based on topography and surface water elevations, that groundwater flows from the Site in a southwesterly direction.

3.0

GROUNDWATER MONITORING FIELD ACTIVITIES

3.1

SCOPE OF WORK

The groundwater monitoring field activities at the Site were performed by CRA on various dates in November and December 1998 and in January 1999. These field activities included the following:

1. Vertical Aquifer Sampling (VAS) at temporary monitoring well location MW2A-98;
2. Installation of three temporary monitoring wells (MW1A-98, MW2A-98, and MW3A-98) at the locations presented on Figure 3.1;
3. Collection of static groundwater level measurements; and
4. Development, purging, and sampling of the temporary monitoring wells for laboratory analysis of dissolved sodium and total chloride.

3.2

VERTICAL AQUIFER SAMPLING

VAS was conducted pursuant to MDEQ's request at temporary monitoring well location MW2A-98 prior to installation of the monitoring well at this location. VAS was conducted at this location to evaluate the general vertical distribution of sodium and chloride within the first competent water-bearing horizon and to assess the most appropriate depth for well screen placement in the three proposed temporary monitoring wells. The VAS was conducted at the MW2A-98 location at discrete approximate 10 foot intervals to a depth of 80 feet into the water table, or 119 feet below ground surface (bgs), as presented in Table 3.1. Vertical aquifer samples were collected using a sequentially decontaminated stainless steel hydropunch to accurately ensure the integrity of the vertical aquifer samples. The hydropunch was lowered through the previously advanced 4-inch outside diameter (OD) steel casing to a discrete interval several feet below the protective casing, as pre-determined by the CRA field representative. The hydropunch was then opened and allowed ample time to capture a groundwater sample. Upon capturing the groundwater sample, a portion of each sample was field filtered through a 0.45  $\mu$ m filter prior to preservation for dissolved sodium and an unfiltered aliquote was collected for total chloride. Collected groundwater samples were field monitored for pH, temperature, turbidity, dissolved oxygen, conductivity, and salinity with a Horiba™ water quality analyzer. Groundwater quality field measurements are presented in Table 3.2.

### 3.2.1 LABORATORY ANALYTICAL RESULTS

Eight groundwater samples and samples from two water sources used for decontamination purposes were collected during the VAS activities and submitted to Safety-Kleen (Encotec), Inc. in Ann Arbor, Michigan (Encotec) for analysis of dissolved sodium and total chloride on an accelerated turn-around time basis (less than 24 hours). In addition to the analysis completed by Encotec, split samples were submitted to General Engineering Laboratories in Charleston, South Carolina (GEL) to verify the comparability of data generated by each laboratory. The analytical results from the VAS are summarized in Table 3.3. Chain-of-custody records are presented in Appendix A. Laboratory analytical reports are presented in Appendix B.

### 3.3 MONITORING WELL INSTALLATION

Three temporary monitoring wells (MW1A-98, MW2A-98 and MW3A-98) were installed at the locations set forth in the approved Work Plan and as presented on Figure 3.1 to determine groundwater flow direction and to assess groundwater quality in the southwest corner of the Site.

#### 3.3.1 INSTALLATION PROCEDURES

The three (3) pilot boreholes for the temporary monitoring wells were advanced with a 4-inch inside diameter (ID) roto sonic drill. Continuous soil sample were collected during borehole installation to accurately describe the lithology of the overburden stratigraphy. Stratigraphic logs for the temporary monitoring wells are presented in Appendix C.

The temporary monitoring wells were constructed with a 2-inch ID, number 10 slot, 10-foot long Schedule 40 polyvinyl chloride (PVC) screen installed into the water table and a 2-inch ID Schedule 40 PVC riser pipe which extended several feet above the ground surface. Well screen depth was based on evaluation of the VAS results (i.e., the depth interval with the highest dissolved sodium and total chloride). A coarse silica sand pack was installed around the screen interval to approximately 2-feet above the top of the screen. A bentonite gravel seal, approximately 2-feet thick, was installed above the sand pack. Bentonite grout was used to fill the remaining annular space from the bentonite gravel seal to three feet bgs. A graded concrete surface seal was installed to promote surface water runoff in the vicinity of each temporary monitoring well.

The borehole for MW2A-98 was installed first and advanced to a total depth of 119-feet bgs. The temporary monitoring well at this location was completed with a screen interval of 55 to 65 feet bgs (938.5 ft to 928.5 ft AMSL) on November 20, 1998. MDEQ provided oversight during the completion on the VAS at MW2A-98 and participated in on-Site discussions regarding monitoring well completion details.

The borehole for MW1A-98 was advanced to a total depth of 57-feet bgs and a temporary monitoring well was completed on November 21, 1998 with a screen interval of 45 to 55 feet bgs (927.5 ft to 917.5 ft AMSL).

The borehole for MW3A-98 was advanced to a total depth of 101-feet bgs and the temporary monitoring well was completed on November 20, 1998 with a screen interval of 91 to 101 feet bgs (913.8 ft to 903.8 ft AMSL).

All screen intervals were selected in the upper portion of the shallow aquifer based upon the VAS results at MW2A-98 and the occurrence of significant saturation in the borehole stratigraphy.

### 3.3.2 WELL DEVELOPMENT

The new temporary monitoring wells were developed on November 20, 1998 and November 21, 1998 utilizing a submersible water pump. Each well was developed by removing a minimum of ten well volumes until a turbidity measurement of less than 15 NTU was achieved.

### 3.4 FIELD MONITORING

CRA measured static groundwater levels in the three temporary monitoring wells installed on-Site. The static groundwater levels were determined by measuring the depth to groundwater in each well on dates in November and December 1998, and January 1999.

Depth to groundwater was determined using a water level indicator. The measured groundwater elevations for each well are summarized in Table 3.4.

### 3.5 MONITORING WELL PURGING AND SAMPLING

Monitoring wells were purged prior to groundwater quality sampling on November 24, 1998, to ensure that stagnant water was removed from the temporary monitoring wells and that water samples collected were representative of aquifer conditions. A submersible pump and new polyethylene tubing were used to purge each monitoring well. A minimum of three well volumes was purged from each monitoring well. Purged groundwater was monitored for pH, temperature, turbidity, dissolved oxygen, conductivity, and salinity to ensure stabilization prior to sample collection. Purge water parameters were measured with a Horiba™ water quality analyzer and are presented in Table 3.5.

Groundwater samples were collected from each monitoring well immediately after monitoring well purging was completed, utilizing the submersible pump and dedicated sample tubing. A portion of each sample was field filtered through a 0.45 µm filter prior preservation for dissolved sodium and an unfiltered aliquote was collected for total chloride.

Groundwater samples were submitted to GEL for analysis and are summarized in Table 3.6. Groundwater samples were transferred into appropriately preserved sample bottles supplied by GEL. Samples were immediately placed into an ice-packed cooler to maintain sample temperature at approximately 4°C. Samples were recorded on a chain-of-custody record and shipped to GEL. (See Appendix A).

### 3.6 DECONTAMINATION PROCEDURES

Decontamination of sampling equipment was completed following CRA standard operating procedures for decontamination. These procedures were followed throughout field activities to reduce the risk of sample cross-contamination and to maintain sample integrity. Prior to water level measurement, and between monitoring wells, the water level indicator was washed with a distilled water and Alconox solution, and then rinsed with distilled water. The Horiba™ Water Quality Meter was rinsed with distilled water between readings.

Clean nitrile gloves were worn in the field at all times during the groundwater level measurement, purging, and sampling activities. A new pair of nitrile gloves was used at each monitoring well to minimize the possibility of cross-contamination.

3.7

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLING

To ensure quality assurance/quality control, CRA submitted one equipment rinsate (field) blank, a field duplicate sample (approximately 10 percent of the total samples) and designated one sample providing additional volume for the laboratory analyses of a matrix spike/matrix duplicate or matrix spike duplicate (MS/Dup or MS/MSD). The field blank and duplicate samples were submitted blind to GEL for analysis.

#### 4.0 GROUNDWATER MONITORING RESULTS

##### 4.1 GROUNDWATER ELEVATIONS

CRA measured static groundwater levels in November and December 1998, and January 1999. The depth to groundwater and groundwater elevations are presented in Table 3.4. The observed data for these events were used to evaluate groundwater flow directions in the southwest corner of the Site. The groundwater flow directions based on the three temporary monitoring wells for December 8, 1998 are presented on Figure 4.1.

##### 4.2 FIELD MONITORING

Groundwater field measurements obtained during the November 1998 sampling event included pH, temperature, turbidity, dissolved oxygen, conductivity, and salinity. The groundwater quality field measurements for each monitoring well are summarized in Table 3.5.

##### 4.3 LABORATORY ANALYTICAL RESULTS

Five groundwater samples were collected on November 24, 1998 and submitted to GEL for dissolved sodium and total chloride analysis. In addition to the groundwater monitoring samples, ten water samples were collected and analyzed for dissolved sodium and total chloride as part of the VAS. The VAS data is presented in Section 3.2.3 (see Table 3.3). No significant chemical gradient was identified through the VAS sampling.

A summary of groundwater sampling analytical data is presented in Table 4.1. Chain-of-custody records are presented in Appendix A. Laboratory analytical reports are presented in Appendix B.

All of the analytical data were reviewed for accuracy and conformance with the analytical methods and generally accepted laboratory procedures. Analytical data was assessed to determine whether any qualification was necessary, based on holding-time periods, method blanks, laboratory check samples, matrix spikes, laboratory duplicates, field blanks and field duplicates. Only minor qualifications were required, as documented in Data Quality Assessment and Validation Memorandum which is presented in Appendix D. All of the data was determined to be of acceptable quality for quantitative evaluation.

## 5.0 SURFACE WATER EVALUATION MAPPING

Surface water evaluation mapping was completed to support the interpretation of groundwater flow directions in the southwest portion of the Site. This activity included the installation and surveying of surface water staff gauges and collection of surface water elevation measurements.

### 5.1 INSTALLATION OF STAFF GAUGES

Surface water staff gauges were installed December 8, 1998 at the six locations presented on Figure 3.1. These locations were selected to provide surface water elevations for the southwest corner of the Site.

### 5.2 SURVEYING OF MONITORING WELLS AND STAFF GAUGES

Surveying of surface water staff gauges and temporary monitoring well locations was completed by CRA on December 14-16, 1998. The survey was completed utilizing Global Positioning System (GPS) and Total Station surveying techniques. Horizontal control was established relative to a local Site grid and vertical control is relative to GM on-Site datum. Vertical control for the staff gauge and temporary monitoring well elevations was surveyed to USGS mean datum, which was previously established at the facility.

The reference point elevation for the three (3) temporary monitoring wells and six (6) surface water staff gauges are presented in Table 3.4.

### 5.3 STATIC WATER LEVEL MEASUREMENTS

CRA measured static surface water and groundwater static water levels on various dates in November and December 1998, and in January 1999, at the six (6) surface water staff gauges and three (3) temporary monitoring wells installed in the area. The surface water and groundwater elevations are summarized in Table 3.4. Surface water and groundwater elevations for December 8, 1998 are presented on Figure 4.1. Based on the groundwater monitoring wells installed in this portion of the Site, groundwater flow was determined to be to the south-southeast.

## 6.0 SUMMARY

The following presents a summary of the groundwater quality assessment presented in this Report:

- 1) Sodium and chloride were reportedly detected in groundwater on the property southwest of the Site, as described in a report prepared for the property owner (Water Supply Evaluation, Insight, July, 1997). The Insight Report assumed, based solely on topography and surface water elevations, that groundwater flows from the Site in a southwesterly direction.
- 2) Three temporary groundwater monitoring wells and six surface water staff gauges were installed in late November/early December 1998 to assess groundwater flow directions and quality in the southwest portion of the Site.
- 3) VAS sampling at MW2A-98 identified dissolved sodium and total chloride levels to generally decrease with depth from concentrations of 610 mg/L and 340 mg/L, respectively, at the water table.
- 4) Based on the groundwater monitoring wells installed in this portion of the Site, groundwater flow was determined to be to the south-southeast.
- 5) Dissolved sodium and total chloride concentrations are summarized for the temporary monitoring wells as follows:

| <i>Monitoring<br/>Wells</i> | <i>Dissolved<br/>Sodium<br/>(mg/L)</i> | <i>Total<br/>Chloride<br/>(mg/L)</i> |
|-----------------------------|--|--------------------------------------|
| MW1A-98                     | 155                                    | 363                                  |
| MW2A-98                     | 219                                    | 440                                  |
| MW2A-98 (Dup.)              | 214                                    | 407                                  |
| MW3A-98                     | 70.8                                   | 260                                  |

- 6) Groundwater quality in the downgradient monitoring well, MW3A-98, did not exceed the Act 451, Part 201 Generic Residential Groundwater Criteria of 160 mg/L (or the Generic Industrial Groundwater Criteria of 450 mg/L) for sodium, and marginally exceeded the 250 mg/L aesthetic criteria for total chloride. MW3A-98 is approximately 400 feet north (i.e., upgradient) of the Site boundary.

- 7) The concentrations of dissolved sodium and total chloride identified in the temporary monitoring wells completed in the southwest portion of the Site are lower than those reported in the shallow aquifer just southwest of the Site.